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(54) System for sorting items

(57) A system for sorting items from loading stations to unloading stations that are not yet established at the moment of the item introduction into the system is provided, in which the items are routed along paths (8, 9, 10) that are determined each time as a function of a particular coding allotted to the item at the moment of loading.

An airport baggage-handling system uses track-guided carriages which carry both (a) a permanent code (eg a bar code) identifying the carriage, and (b) a temporary code identifying the luggage and thus the required destination. The two codes are associated in a central computer and provide a double check that the right carriages reach the right destination. Code readers are provided along the track for controlling points (14). The carriages each include a microcomputer controlling its drive motor, and a transceiver for information which is transmitted along the system bus bars.

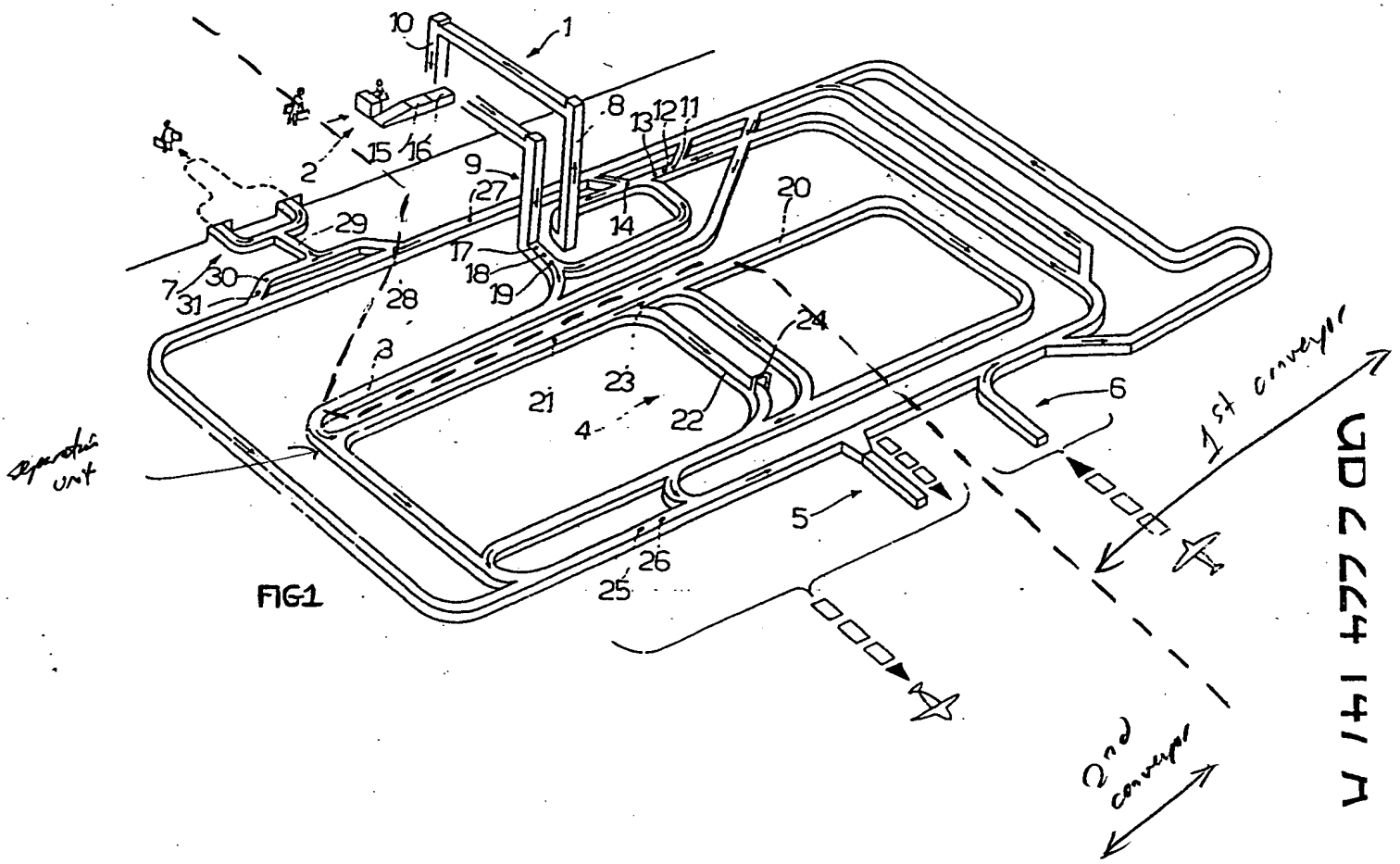
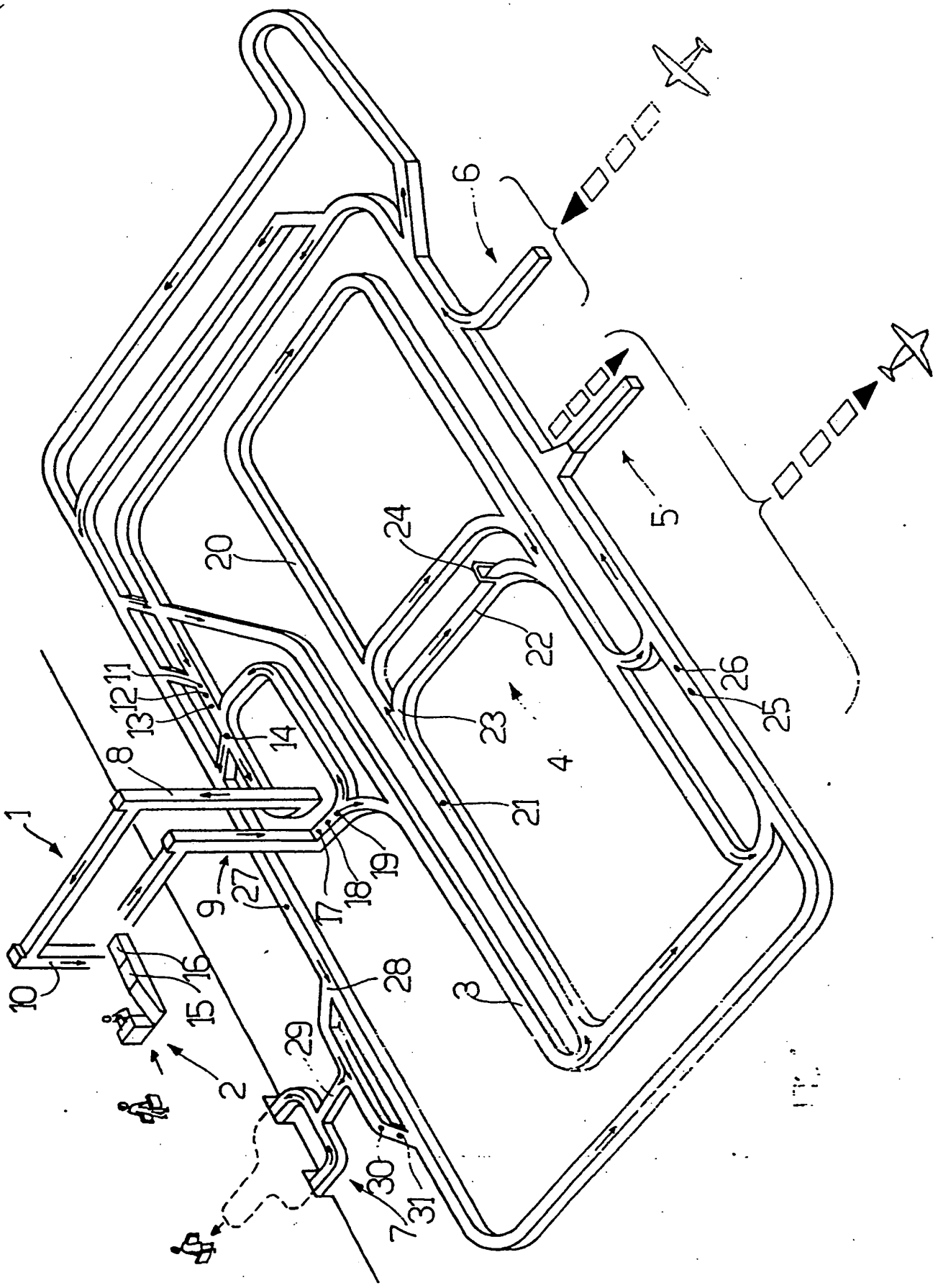


FIG1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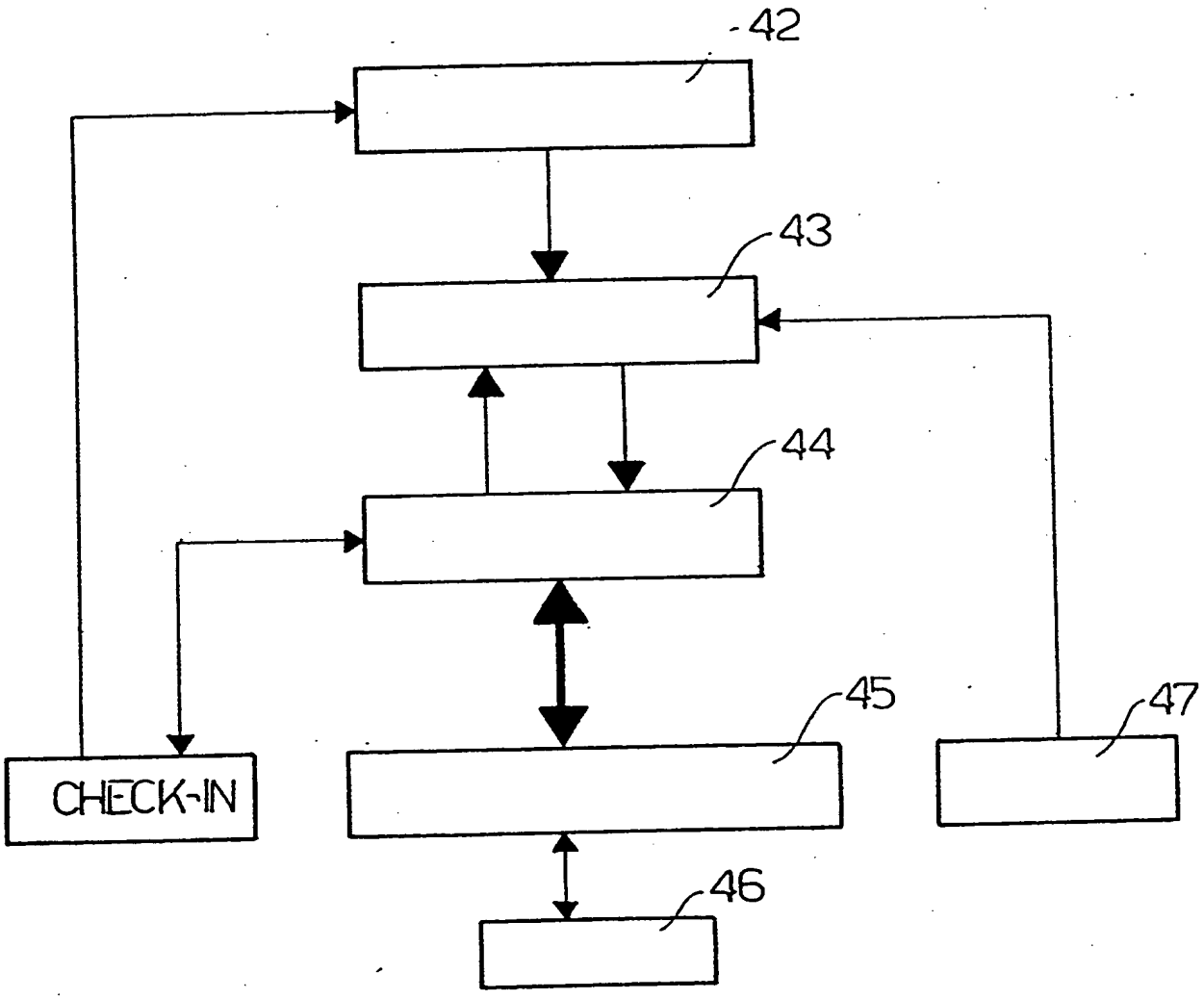


FIG 2

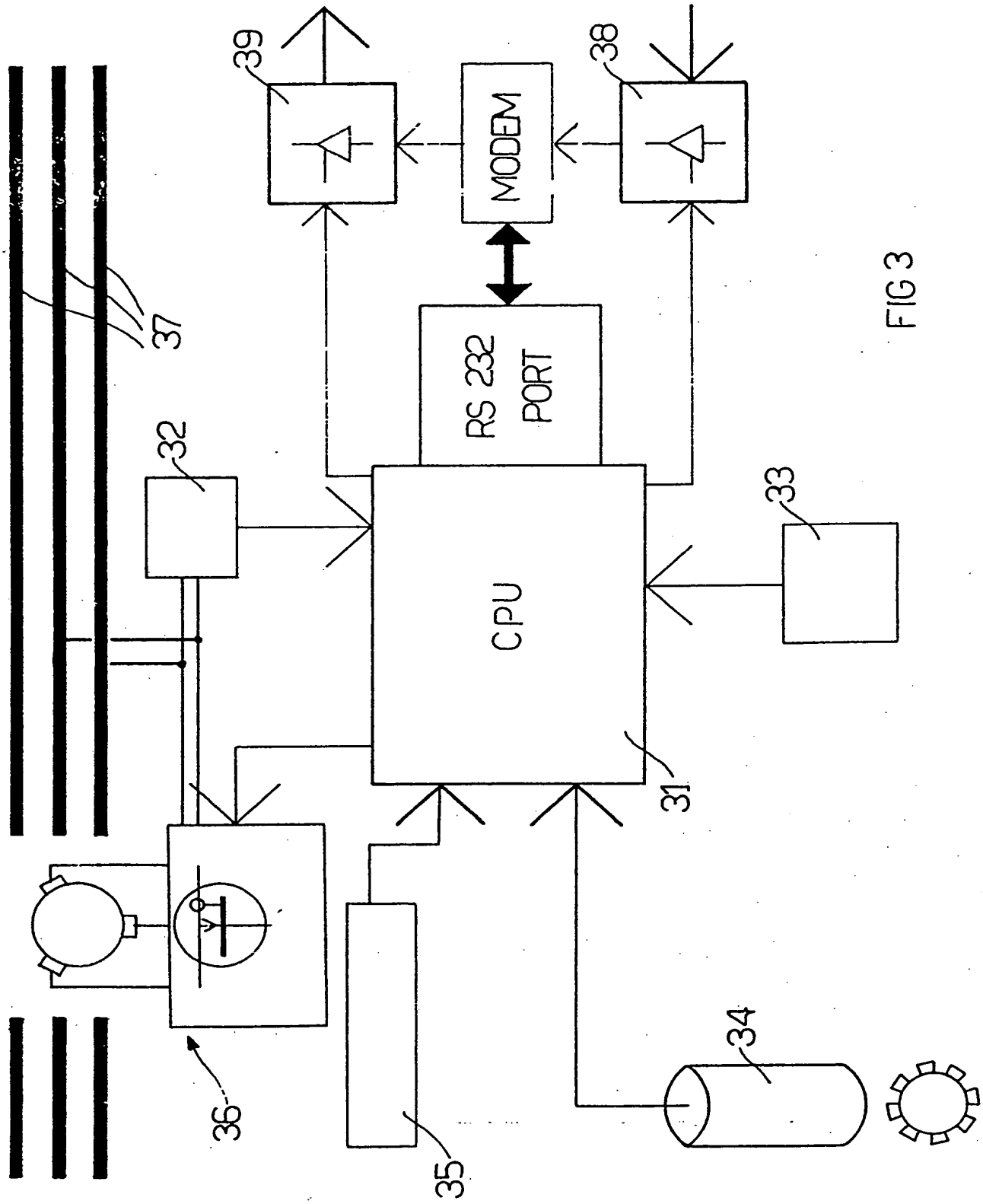


FIG 3

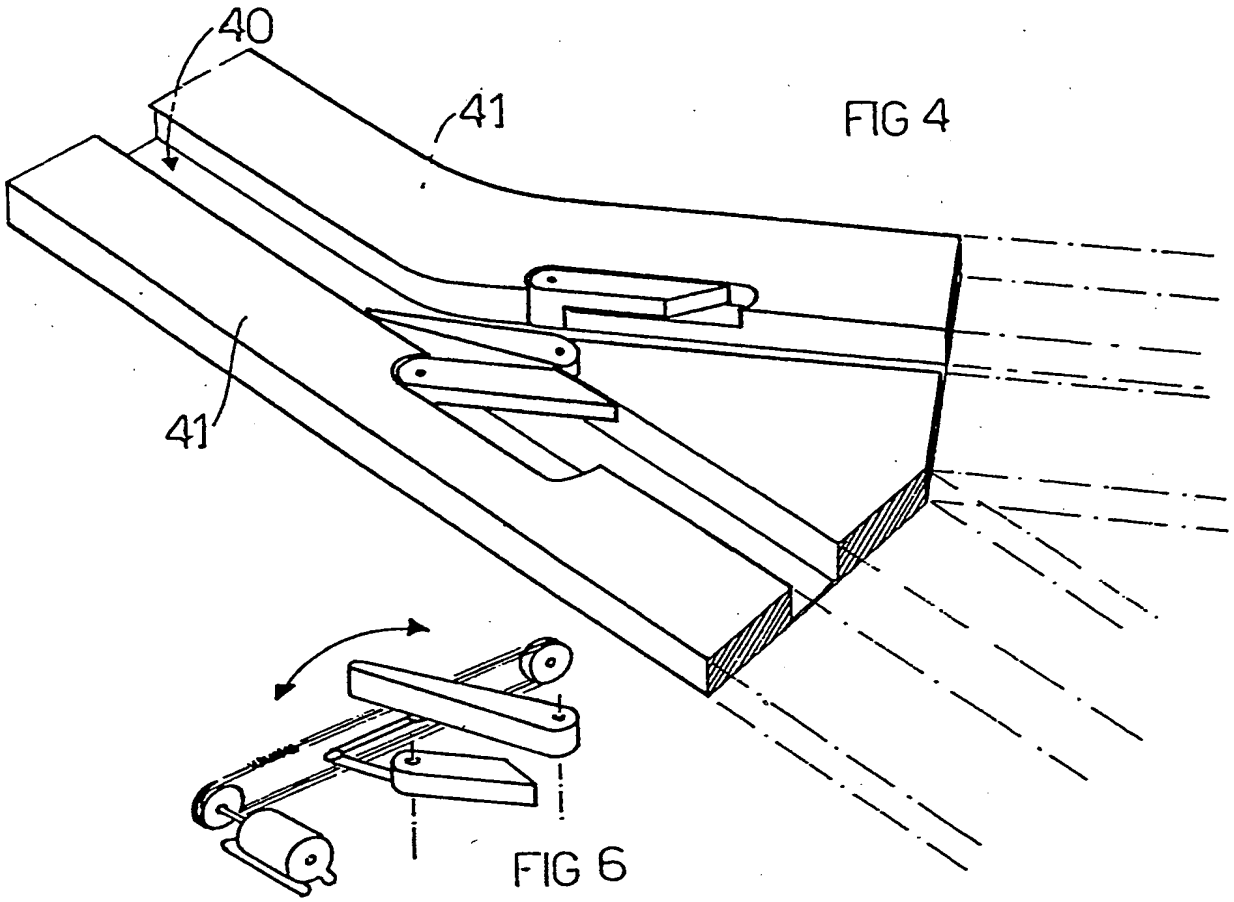


FIG 4

FIG 6

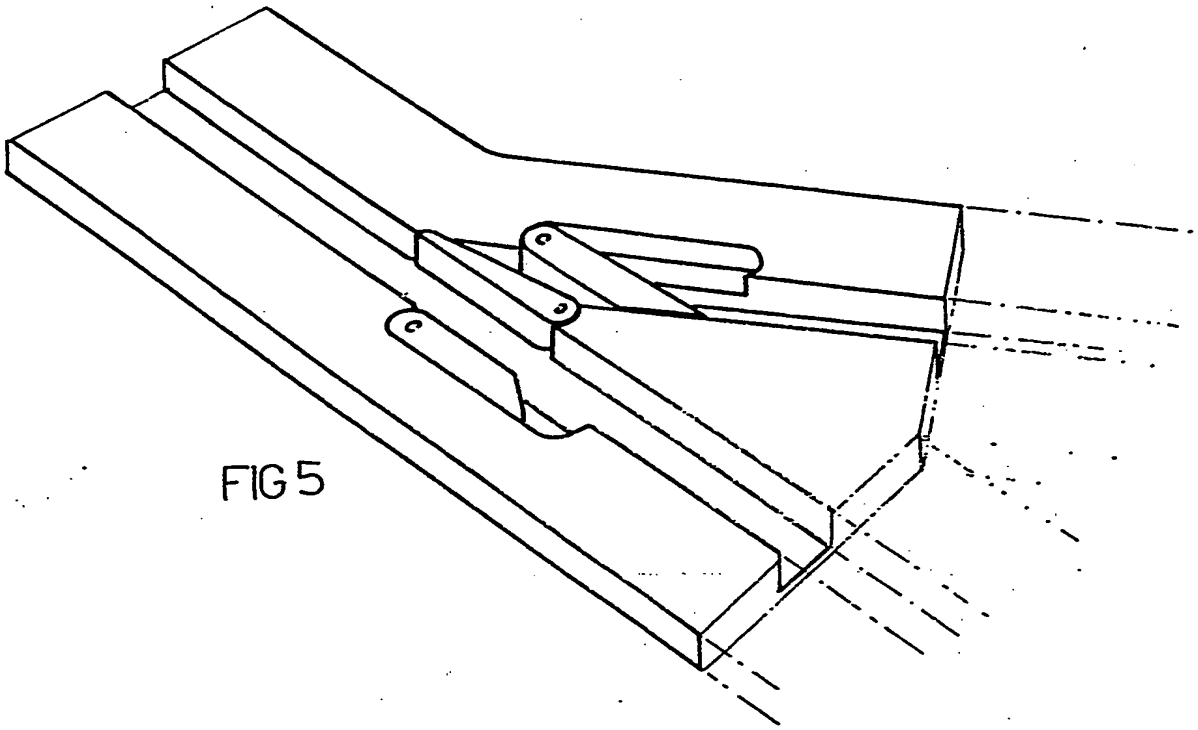


FIG 5

PROCESS AND APPARATUS FOR SORTING ITEMS

This invention relates to a process and apparatus for sorting items, and particularly but not exclusively to such a process and apparatus for sorting items from loading stations to unloading stations, the location of which is not yet established at the moment of loading or introduction of the items in to the system, as is the case, e.g., of luggage sorting in airports where it often happens that, at the moment of check-in, the sorting point towards which such luggage should be directed has not yet been decided.

The luggage is conveyed by carriages, each of which is electronically distinguished by its own fixed code, to which is associated, at the moment of loading, a code that can vary each time, identifying the item destination.

Along a path travelled by the carriages in proximity to switches, are devices capable of reading such codes as the carriage is passing, and of acting accordingly upon the switches or points so as to direct said carriage towards the pre-established sorting point.

There are known conveying and sorting systems wherein a plurality of carriages move along a pre-established path and unload the items at pre-determined points of the path, corresponding to as many different final destinations.

In systems of this kind the item at the moment of loading is given a code that corresponds to its destination. Suitable devices, either spaced apart along the path or centralised, are provided for controlling the carriage as it proceeds along its path, and for actuating the devices that effect the unloading when the carriage passes before the corresponding collecting station.

Generally, in this kind of system loading the introduction points of the items are relatively few, whilst there may well be many destinations, and therefore many unloading stations. Typical plants of this type are the item sorting plants in post offices or the order sorting systems in the big mail order companies.

In other cases, such as e.g. luggage handling in airports, the introduction points are many, whilst the unloading stations or areas are few and not yet established at the moment of check-in.

It is not therefore possible to arrange a fixed and direct path between introduction and sorting points, and it is not accordingly possible to give the item a distinctive code of the unloading station.

Further, the introduction of items in the plant may even be carried out a long time before the time of departure, which requires that the luggage be kept in parking zones before being selectively directed towards the sorting stations.

There are known methods for automatizing the luggage conveyance from the check-in to the unloading areas, methods that however do not solve the problem completely.

For instance, U.S. Patent 4.058.217 refers to a process for applying to each item of luggage a label dispensed by a special machine, on which is written an automatically readable information concerning the destination to which the luggage is to be directly by a central computer.

This system, however, does not take sufficiently into account the fact that often at the moment of check-in there isn't any free sorting point or the same has not yet been established. The bulk storage is shared by all the carriages, that is to say it is not differentiated by destinations. Lengthy operations are therefore necessary to recover the luggage intended for a determined destination (when the same becomes free) because of the random storing conditions.

It is therefore necessary to have recourse to manual sort which diminishes the efficiency of the whole system.

U.S. Patent 4.239.434 describes a process based on the

detection of the luggage weight, which however disregards the fact that the pathways the luggage has to follow in order to move towards the sorting points are not pre-determinable. Actually, such a process can only be used for stationary pathways.

U.S. Patent 3.260.349 deals with the problem of storing luggage before sending it to the unloading stations; a problem that is quite unsatisfactorily solved by recirculating the baggage. Such an unselected storing system gives rise, however, to many inconveniences.

Reference has been made to these patents - however unsatisfactory are the solutions they put forward - as an indication of the current interest in airline baggage handling.

From the above it clearly appears that baggage sorting in systems of the open path kind is a very complex problem.

According to a first aspect of the present invention there is provided a process for sorting items in an open path routing system, wherein each item to be sorted is loaded on a moving carriage, controlled by electronic systems connected with a main computer, along sliding ways interconnected by switches or points, wherein to each carriage, permanently identified by a fixed code, is allotted from time to time, at loading, an identificatory code of the various data relevant to the final destination of the conveyed item, said code being used by logic devices arranged along the path, in order to control switches or points and to route the carriages towards the expected destination.

In this process items such as luggage are conveyed by carriages to each of which is given, upon induction in the system, a code containing all the necessary information for the identification of the luggage. More specifically, such code or mark can consist of a plurality of fields in which are inserted, in a coded form, the data relevant to a range of various information, such as e.g. the name of the air company, the number of the flight, the name of the passenger and the like.

The carriage is provided with its own fixed code, e.g. of the bar kind, that identifies it and is detectable by readers of known type set along the path in the proximity to the switches.

There is the provision for said code to be associated, in the memory of the central computer that controls the whole system, with the above mentioned information, so as to enable the system to perform further operations.

Each carriage is thus identified by two distinct and independent codes: the mark allotted according to the task to be performed, and the bar code, that is fixed and identificatory of that particular carriage.

The mark is read by devices that, by acting on the switch devices, route the carriage toward its proper destination; the bar code, detected along the path too, supplies the central computer with an information allowing to verify that to each carriage correspond a determined task.

It is matter of a cross-check system, intended to avoid mistakes in the sorting of the luggage.

In fact, if the mark is sufficient to route the carriage towards the pre-determined collecting station, the bar code enables an additional check that each carriage has brought its task to an end properly, e.g. by checking that all the carriages charges with given task - and only those-have arrived at a pre-determined unloading area.

The cited information can be inserted in the central computer even in association with other data, such as the progressive check-in number, the check-in counter number etc.

In this way the system is provided with any useful data to the identification of the carried item and of the conveyor means.

According to a second aspect of th present invention there is provided a process for sorting items, wherein each baggage item is loaded on a carriage running along pathways interconnected by switches or points and earmarked

by a permanent code, in which,

to the permanent code of each carriage there is associated a temporary code, identificatory of the baggage destination;

said code is stored, until unloading has taken place, in an electronic system, that controls the whole apparatus;

a specific path is allotted to each said carriage;

the information relevant to the path of each individual carriage is transmitted, as a function of the code number of the carriage itself, to the switch or points control devices;

as each carriage advances, its associated codes are detected by devices set in the proximity of the switches or points, and information received by the general control system, as a function of the detected code association.

According to another aspect of the present invention there is provided apparatus for carrying out the aforementioned process, including a sorting system comprising several paths interconnected by switches or points, a plurality of carriages that run along said paths, each distinguished by a fixed code,

means for associating to the fixed code of each carriage a temporary code identifying the end destination of the carried items;

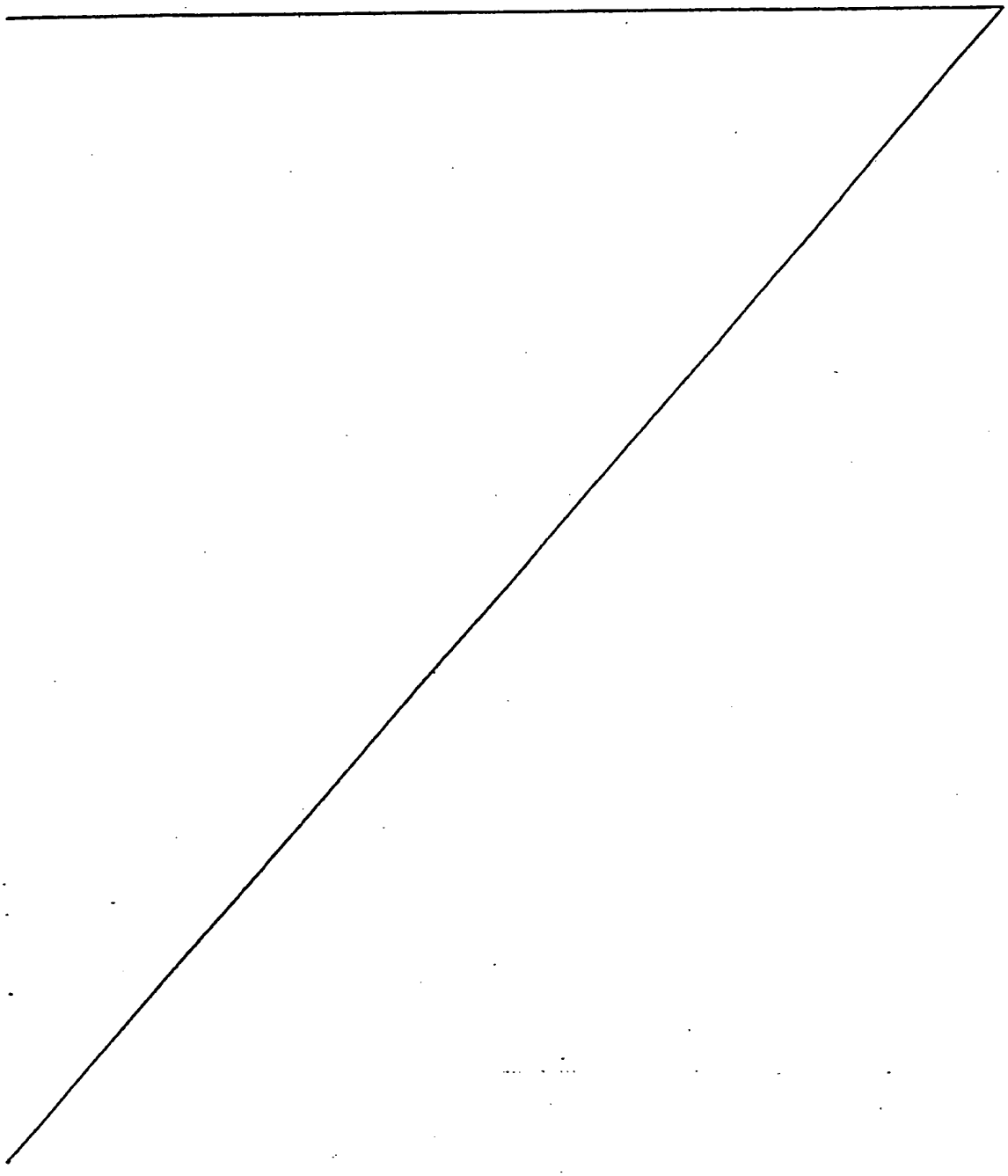
means set along the path, for continuously detecting the codes of each carriage and for operating the appropriate switches or points; and means for actuating the unloading of the carried items as the carriage passes before the collecting areas.

The present invention will now be described in detail, by way of a non-limiting example, with reference to the accompanying drawings, in which:

Figure 1. is a schematic perspective view of apparatus for airline baggage sorting, for putting the process of the invention into use,

Figure 2 is a block diagram of a baggage logic routing,

Figure 3 is a block diagram of electronic devices mounted on each carriage of the apparatus of Figures 1 and 2,



Figures 4 and 5 show in perspective views a type of switch than can be used in the apparatus of Figure 1, and

Figure 6 shows schematically mechanical devices for actuating the switch of Figures 4 and 5.

An apparatus of the invention for sorting items, as shown in Figure 1 includes a plurality of blocks, namely:

a carriage accumulation area 1, each carriage being marked by a code that reveals whether the same is available or not;

a plurality of check-in zones 2;

a main circuit loop 3;

storage zones 4 for carriages destined to flights that have still to go through the loading phase;

unloading areas 5;

loading zones 6 for the incoming and transiting baggage;

pathways 8, 9 and 10 for moving the carriages e.g. from the path to the accumulation area, then from the latter to the check-in, and again to the path.

Each carriage is preferably provided with an independent motor that makes it advance in the open path zones; in the fixed path zones, instead, such as for instance the accumulation and loading zones in the proximity to the check-in, or the uphill and downhill routes (when the plant is on different levels) the handling will be preferably obtained by means of chain, so that the carriages will shift in a synchronized manner in all these areas of the path.

No detailed description of the single devices making up the plant is provided, as they are generally of known type or have been illustrated in other patents such as the prior art references.

Programmable logic control devices - hereinafter referred to as "PLC" - are located in the proximity to the road

network switches and are supplied with the information relating to the outgoing flights that are to be loaded.
These devices, that perform the function of programmable local controllers, control the actuation of the routing means such as switches or the like, so as to make the carriage that is passing before the controller reach a specific destination through the optimum pathiway, according to the code with which it is marked.
It is provided that an exchange of information take place between the carriage and the fixed PLC devices, concerning the identification codes; in case of coincidence between the read and the stored code, the devices will provide for routing the carriage toward a pre-established sorting point; otherwise, the carriage will be routed further along the path and, if necessary, to the storage area destined to each flight.
The messages sent by the carriages may even contain availability or breakdown information; in that case, the PLC devices will direct the carriages to the collecting areas or to repair zones - if any.
As already said, the conveyor carriages are preferably self-driven; the motor feed is controlled - via devices of known kind - by a microcomputer mounted on board of the carriage to which sensors set on its wheels send indications as to the operative conditions concerning both the path (e.g. passage through long running pathways, accumulation areas, normal transit areas etc) and the traffic (lines, obstacles etc.), so that the logic devices can adjust the travelling speed of the carriage to the different operative conditions, with a view to reaching the maximum allowable speed.

Other sensors signal to the logic devices the presence of a fixed obstacle and/or the contact of the carriage with outer elements such as other carriages; in this case, the logic devices will set the motor to minimum speed conditions, in order to possibly remove the obstacle. When a fixed obstacle is found on the path, the feed is discontinued and the control devices make repeated attempts, at determined intervals of time, at restoring the circulation.

In correspondence of the storage areas, where the carriages are usually in contact with one another, a special tone or modulated carrier is inserted in the bus bars, whereby the microcomputer, that is informed by said tone of being in a stonage area, would eliminate the timed attempts of the PLC devices at reinstating the circulation; when the tone disappears, the handling can be actuated again.

The process may be defined therefore as an asynchronous sorting process, using open paths, wherein a Main Control Computer (MCC) 'dialogues' with the controlled elements, by detecting information and sending instructions; to the different degrees of responsibility of the various devices correspond different language levels.

At the first level the main computers MCC are network linked with the Airport Information System (AIS) and with the Logistic Information System (LIS) respectively, as well as with a control room.

The plant by-systems operate at a different language level, more suitable to the kind of information and instructions that are exchanged between the main computer and the Path Control Units (PCU), the latter having the function of managing the traffic in the various zones such as the

accumulation storage areas etc., into which the path is divided.

A yet more simplified language level is adopted for the 'dialogue' between the Path Control Units (PCU) and the programmable local controllers PLC, that are to read the message marked on the carriage, control the switch actuators, identify the data coming form the sensors that detect the switches position.

The PLC receive instructions on how to behave in the presence of carriages provided with given codes: each carriage continuously transmits the datum it has been given (e.g. an air company-flight-destination combination) when it is on a transport 'mission', or a code revealing that it is free to go on an mission, or a breakdown code so that it can be intercepted by a test station).

In the proximity to the switches a fixed receiving device receives the code transmitted by the carriage and sends it in turn to the local PLC that, according to whether the code belongs to a carriage to be intercepted, acts or not upon the switch electromechanical control.

For a better understanding of the invention process, there will be described in detail the various sorting operations corresponding to the different zones in which the plant is divided.

<u>Loading at the check-in points</u>

A fixed receiver 11 detects from the incoming carriages the code indicating that such carriages are emply and can be loaded; as transmitter 12 marks a fictitious code, and a receiver 13 checks that such fictitious code be accurately reproduced by the carriage; if this is the case, the carriage is directed, via switch 14, to the uphill running stretch of path 8, wherefrom it arrives at the accumulation

zone 1.

From zone 1 the carriages, through the downhill running stretch 10, arrive at the check-in points where the baggage is weighted and its sizes are automatically checked.

At this point the operator, by means of a keyboard, impresses on the baggage the air company-flight-destination code, code that is stored in the local PLC. The PLC that controls the check-in zone reserves then one of the free incoming carriages and controls that the baggage be transferred from the loading station to the carriage, by means of an induction belt 16.

After going past the downhill path 9, the carriage passes before a transmitter 17 and marks it, adding to the carriage fixed code the information relating to the task to be performed.

This information is checked by the following receiver 18 that, in case of a positive result, activates the association between the fixed code of the carriage (checked by the bar code reader 19) and the data relevant to the 'mission' (passenger name, air company, flight, destination) in the data-base of the main computer system.

The carriage enters then the main sorting loop and begins to move autonomously, via the motor on board, while going on transmitting its code identifying the baggage, the carrier, the destination etc.

Each time a carriage comes near a switch, suitable devic s detect the code thereof and act upon the switch in accordance with the instructions provided by the main computer: if the flight is to undergo the loading phase, the switches will be activated to send the carriage to the respective area, whilst if the flight is not yet ready the carriages bearing such code are routed toward the storage

The empty carriages are intercepted and recirculated to the zone opposite the uphill stretch 8.

Storage areas

The carriages destined to the storage areas are directed along circuit 20: when a fixed receiver 21 senses the code of a carriage that is to be stored to an area within its province, e.g. area 22, it opportunely activates switch 23. If an area is intended for storing the carriages marked by a determined code, there is set in interception position a mechanical blocking device 24, that constitutes the stop for the first of the stored carriages; if an area is not prepared to store the carriages marked by a certain code, the mechanical blocking device is kept in a non-interception position, converting thus that area in an ordinary pathway that can be exploited when alternative routes are required.

As soon as an unloading area is declared to be available to the carriages marked by a certain code, the mechanical blocking device in the storing areas containing the carriages identified by that code is brought to a non-interception position; at the same time, the logic control devices mounted on the carriages distinguished by that code are informed of this new state, making the carriages move forward and enter the pathway leading to the unloading areas.

Conveyance of the baggage to the unloading zones

The carriages coming from the main sorting loop 3 and from the accumulation areas are identified by a receiver 25 and by a bar code reader 26.

As the carriages arrive at the unloading areas 27 they unload the baggage automatically, via devices such as for instance a revolving belt mounted on the carriage or the

like.

Once the carriages have gone past the unloading area, further control devices check that the baggage has actually been unloaded, and impress on the carriage an 'availability' code by the already mentioned methods.

Then the carriage starts recirculating over the plant or, according to the requirements, can be driven to a storage area specifically meant for empty carriages.

Sorting of the incoming baggage

The baggage dischargeed by an incoming airplane is loaded on the carriages in zone 6, and each carriage is earmarked, according to circumstances, either by a destination code relating to one of the delivery carrousels, or by a code indicating that the carriage is to be transferred to other flights.

If receiver 27 receives a code indicating that the destination for the incoming carriage is e.g. carrousel 7, it would act on switch 28.

The bar code reader associated with receiver 27 verifies the carriage code in order to check that said carriage was actutally loaded with a baggage item having such destination, after which the carriage performs unloading to a conveyor 29 that carries the baggage to the delivery carrousel.

After unloading, the carriage is marked by transmitter 30 with an 'availability' code, and receiver 31 checks that this code be correct before the carriage is released to the main path.

On the contrary, if the baggage loaded on the carriage in correspondence of the arrival zone 6 were directed to another flight, the relevant carriage would be circulated in the main sorting loop, and then handled as though it

came from the check-in.

Selective pick-up of a piece of luggage

For selective picking up a piece of luggage from a storage area the identificatory number of each conveyor carriage is used.

In fact, in the system data-base there is stored the association among baggage identification code, passenger's name and distinguishing number of the conveyor carriage, the latter being identified via the bar code.

For picking up an individual baggage item, the carriages of the involved storage areas are handled: when the sought for carriage passes before the bar code reader, the code or mark previously allotted at the moment of check-in is replaced by another destination code, and the carriage is routed along the main path and then to the desired zone.

An analogous process may be adopted in order to intercept a piece of baggage already in the proximity to the unloading areas.

To round off the specification, there will be now described the devices employed for actuating the invention process, even though they do not form the object of the claims, and some of them are already known because they were described in previous patents or applications by the same Applicant, for instance the Italian Pat. 1.140.188 or the Italian Applications 22264 A/84, 23110 A/84, 20779 B/85 and 24227 B/85.

The most important devices for carrying out the above mentioned operations are: the carriages, the tracks, the programmable control devices and the pusher elements.

Each carriage is provided with an unloading unit that can be handled both via independent motors mounted on board of the carriage, and via outer means such as chains, elevators etc.

On each carriage there are mounted unloading devices of knwon type, such as e.g. a revolving belt forming the transport plane on which are laid the items to be sorted, that can be actuated by known means both by an independent motor linked to the driving roller of the belt or by an outer motor means located in correspondence of the unloading stations and suitable to be engaged by connecting devices on board of the carriages and linked to the belt driving roller.

The carriage is equipped with a microcomputer, a trasmitter-receiver some sensing devices such as a proximity sensor, an anti-collision sensor and a mechanical block sensor.

Fig. 3 shows the connection diagram wherein:

31 is the microcomputer that processes the various received information and controls the carriage functions;

32 is a zone decoding device that identifies the tone present on the bus bar, sending a corresponding signal to the microcomputer;

33 is a mechanical block sensor, e.g. a magnetic sensor that detects any mechanical blocks actuated by the control system, e.g. the block of the storage areas;

34 is a sensor that detects the motion of one wheel of the carriage and sends a signal to the microprocessor to inform it that motion is actually in progress;

35 is a proximity and contact sensor that detects the presence of obstacles along the path, sending a signal to the microcomputer so that the latter can reduce the forward speed in order to avoid collisions;

36 is the carriage motor unit controlled by microcomputer 1 and fed through bus bars 37 that, besides providing the power supply, are traversed by electric signals that, opportunely decoded, inform the microcomputer of the

position of the carriage;

38 is the input line of the mark signal impressed on the carriage and containing the characterizing data of the 'mission' to be performed;

39 is the output line of the mark signal that identifies the carriage an that is continuously given out, to be received by the PLC devices that will take the proper steps for the correct destination of the carriage itself.

The tracks or switches, shown in the Figgs. 4 to 6, are provided with deviators that allow to adapt the path to the programme established for each carriage.

These switches are engaged by respective guide wheels running in seat 40 and secured to the carriage; the switch control, that may be both electric and pneumatic, is commanded by the PLC units.

As it moves forward, the carriage rests via idle wheels on rails 41 that act as slideways.

These slideways are shown in Figgs. 4 and 6, the deviators being in two possible positions that define the carriage route.

The programmable controllers are electronic devices located near the switches of the track system and are equipped with transceivers and with programmable logic devices.

In compliance with the programme, PLC devices control the switches e.g. by means of an electric servo-motor.

Fig. 2 shows the block diagram of the PLC logic, wherein:

42 is the airport main computer;

43 is the node that processes the information coming from computer 42 (it receives information concerning the flight times and the beginning of the loading operations; it receives from the check-in points the data relevant to the

baggage; it associates the destination hint received by 42 to the relevant piece of baggage; it informs the other devices of the destination; it decides the optimum path for each piece of baggage; it informs the other control devices of the path allotted to each baggage item; it checks that the baggage present in the system has been properly sorted); 44 is the by-system that controls the plant topology, keeps node 43 informed of the operational conditions of the system, provides via videoterminal the information necessary to the control of the system;

45 is the PLC network that operates the sorting of the carriages by actuating the switches, and consists of a certain number of PLC units linked via high speed local network to by-system 44;

46 is the microcomputer onboard of each carriage, that exchanges information with the system.

47 is a bar code reading device that detects the numer of each carriage.

Upon inducting the baggage in the sorting system, whereby baggage is allotted to the respective carriages, the PLC unit set at the beginning of the circuit receives the identification code, and transmits it to the carriage when the latter passes before it.

The pushers are devices e.g. of pneumatic type controlled by electromagnets or by cams that are actuated either electrically or mechanically by the carriage itself, and are located in correspondence of the passages from one transport system to the other; more specifically, in those points where the carriage passes from a pathway along which it runs by the action of its own motor to a pathway where it is driven by chains, as it occurs for instance in the uphill and downhill passages 8, 9 and 10 or in the accumulation area 1.

The actuation of the pusher element is made syncronous with the elevator, either during its upward or downward motion, so that the carriages is pushed on the conveyor at certain time intervals determined by the operational cycle of the conveyor itself.

CLAIMS

1. A process for sorting items in an open path routing system, wherein each item to be sorted is loaded on a moving carriage, controlled by electronic systems connected with a main computer, along sliding ways interconnected by switches or points, wherein to each carriage, permanently identified by a fixed code, is allotted from time to time, at loading, an identificatory code of the various data relevant to the final destination of the conveyed item, said code being used by logic devices arranged along the path, in order to control switches or points and to route the carriages towards the expected destination.

2. A process for sorting items wherein each baggage item is loaded on a carriage running along pathways interconnected by switches or points and earmarked by a permanent code, in which,

to the permanent code of each carriage there is associated a temporary code, identificatory of the baggage destination;

said code is stored, until unloading has taken place, in an electronic system, that controls the whole apparatus;

a specific path is allotted to each said carriage;

the information relevant to the path of each individual carriage is transmitted, as a function of the code number of the carriage itself, to the switch or points control devices;

as each carriage advances, its associated codes are detected by devices set in the proximity of the switches or points, and information received by the general control system, as a function of the detected code association.

3. A process according to Claim 1 and Claim 2, wherein each carriage can start its travel only after the proper association between the permanent code and the temporary code given to the carriage itself

has been checked.

4. A process according to any one of Claims 1 to 3, in which logic devices onboard of each carriage are informed of the exact position of the carriage itself along the path by means of a modulated carrier along feed lines of a carriage motor.

5. Apparatus for carrying our the process according to any one of Claims 1 to 4, including a sorting system comprising several paths interconnected by switches or points, a plurality of carriages that run along said paths, each distinguished by a fixed code,

means for associating to the fixed code of each carriage a temporary code identifying the end destination of the carried items;

means set along the path, for continuously detecting the codes of each carriage and for operating the appropriate switches or points; and means for actuating the unloading of the carried items as the carriage passes before the collecting areas.

6. Apparatus according to Claim 5, wherein each carriage is provided with an independant motor, said motor being fed with electric current via bus bars set along the path.

7. Apparatus according to Claim 6, wherein a modulated carrier is introduced in the bus bars in correspondence to the various path section, there being provided on each carriage electronic means suitable to detect said carrier and to control accordingly the various functions of the carriage, according to the path zone in which the carriage is itself.

8. Apparatus accoridng to any one of the preceeding Claims, including path sections along which the carriages move asynchronously, and pre-established path sections along which the carriages move synchronously, driven by external means.

9. Apparatus according to any one of the preceeding Claims, wherein the track unit comprises storage areas for the empty carriages, areas for coding and loading carriages with baggage, recirculating areas for the empty carriages, where the same are sent back to storing, accumulation areas for the loaded carriages, baggage unloading areas, and areas for routing the empty carriages to the storage zones.

10. Apparatus according to any one of the preceeding Claims, wherein on each carriage are provided microcomputing devices for storing the information sent by sensors located onboard the carriage in order to make it stop or move forwards, at convenient speed.

11. Apparatus according to Claim 10, wherein said sensors are proximity sensors and contact sensors.

12. Apparatus according to any one of the preceeding Claims, wherein the information system uses different language levels according to the complexity of the functions it controls.

13. A process for sorting items, sunstantially as hereinbefore described with reference to the accompanying drawings.

14. Apparatus for sorting items, substantially as hereinbefore described with reference to the accompanying drawings.

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